90-06316/1

# CONSERVATION STRATEGIES, SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

By E. Manning, B. Rizzo and E. Viken
Sustainable Development
Environment Canada

Sustainable development is a long-term goal for all society. While there is broad debate on the precise definition, some commonalities have emerged. Sustainable development means development which meets the needs for the present without diminishing the ability of future generations to meet their needs (CCREM 1987). Economists have suggested this means living off the interest while maintaining the environmental capital. Overall, sustainable development implies development which respects the constraints of the environment while taking full advantage of environmental opportunities.

The organizers of this conference suggested to the authors a particular focus - the relationship between conservation strategies, sustainable development and climate change. This presented an interesting problem. The focus of this paper is on relationships - a way of looking at sustainable development so that such major alterations in the system as climate change can be seen in the light of their impact on the environment and economy. This will permit analysis of how conservation and sustainable development strategies relate to promoting long-term system sustainability in the face of human impact on the environment.

Sustainable development rests directly upon knowledge of the environment and its ability to produce the full range of functions upon which the satisfaction of our goals (social, economic and environmental) depend. To permit better understanding of this relationship we put forward a broad conceptual model of environment-economy relationships which can aid in understanding the source of the stresses we put on the environment and the ability of the

environment to respond. This model portrays the physical environment as the supply side of a supply/demand model (Fig. 1). While this is a dynamic model, we would begin by presenting its static state before discussing some of the dynamics of the model through different iterations. This model will allow us to understand the human/biosphere interactions, and to identify potential points for active interventions.

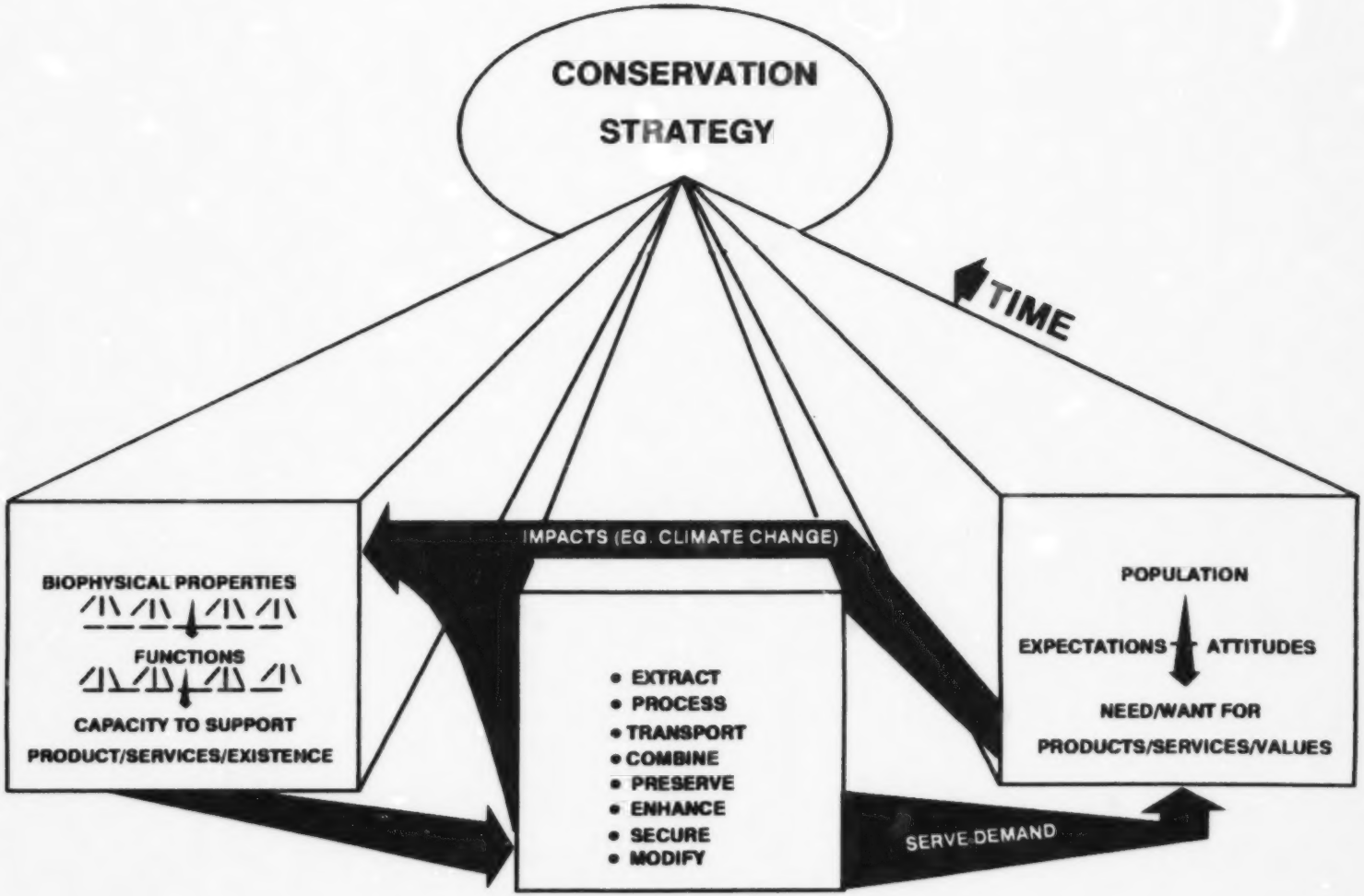
## The supply of environmental functions

The supply side of the model puts forth the concept of the environment as a source of environmental functions. Each ecosystem or each distinguishable part of the environment can be described in terms of a range of measurable, biological or physical variables. Combinations of these variables (e.g. climate, parent material, biota), yield the capability to support different ranges of environmental functions. De Groot's work has identified a very broad range of functions that the environment can support, ranging from productive functions, carrier functions, buffering functions, information functions, etc.(De Groot, 1987) - These functions have the potential to produce a very extensive range of goods, services, values, etc., although not all simultaneously (Manning, 1988a). Any given environment therefore has a certain range of potential to serve the full range of human wants and needs. This can be translated into for example, capability for corn production, visitor experiences, knowledge, buffering of particular toxics, etc. It is at least theoretically possible to estimate the productivity-response for any or all of these products from any given environment (e.g. a particular wetland) in its current state (Manning, 1988a, Smit 1981).

## Demands on the environment

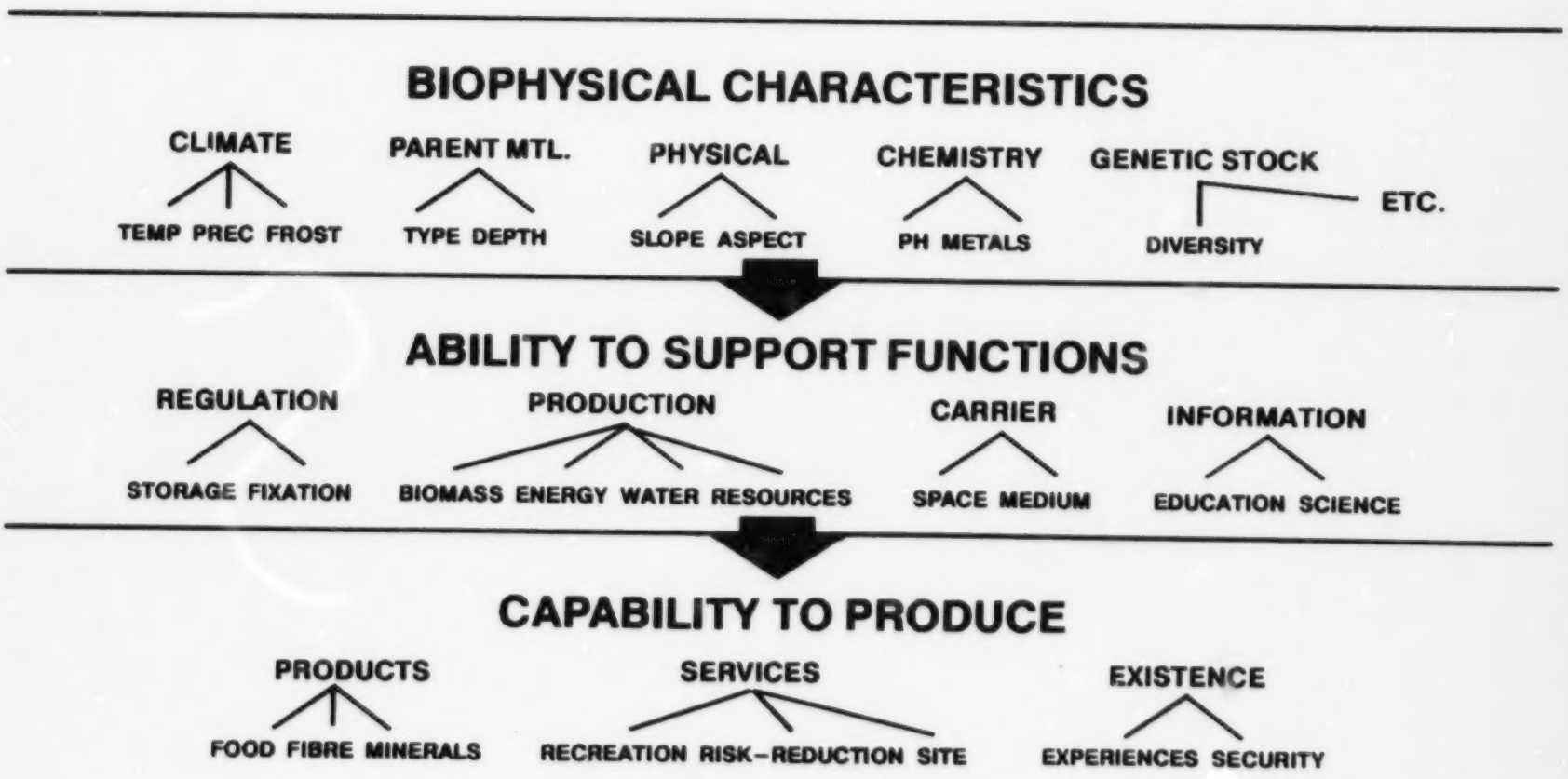
The demand side of the model is population powered. The demands placed on the environment (this is a very anthropocentric approach) depend upon the attitude and expectations of different numbers of humans (See

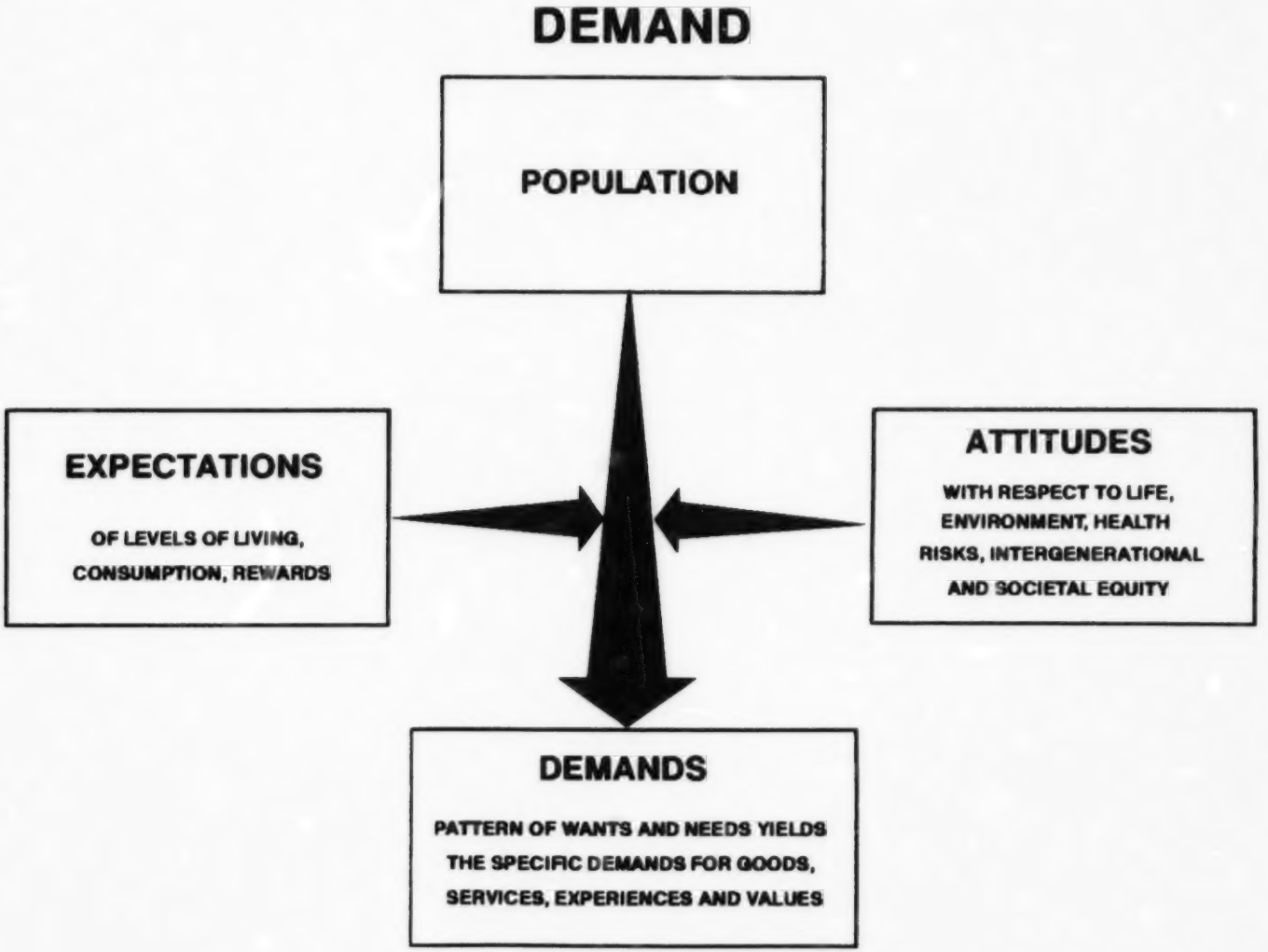
# SUSTAINABLE DEVELOPMENT



# SUPPLY

## (ENVIRONMENTAL BASE)




DEMAND
POPULATION
EXPECTATIONS
OF LEVELS OF LIVING, CONSUMPTION, REWARDS
ATTITUDES
WITH RESPECT TO LIFE, ENVIRONMENT, HEALTH RISKS, INTERGENERATIONAL AND SOCIETAL EQUITY
DEMANDS
PATTERN OF WANTS AND NEEDS YIELDS THE SPECIFIC DEMANDS FOR GOODS, SERVICES, EXPERIENCES AND VALUES

McCuaig and Manning, 1982). These yield a particular range of demands for products, services, experiences, existence values (Bardecki et al., 1988). In principle, these values can encompass all values, including those associated with simply knowing that something exists, or maintenance of variety or genetic diversity.

Transformations

Because the range of products, goods and services naturally provided by the environment is seldom identical to the range of demands being placed upon it, transformation functions occur to alter the supply to satisfy the demand. These transformation functions may be quite simple (i.e. picking the apple and taking it home) or very complex involving the transportation, combination, distillation and packaging of many different substances. Transformation can also include preservation, enhancement, conservation as well as extraction, processing, etc. As society's numbers grow and expectations change, the range of demands placed on the environment to produce goods, services, experiences, etc. changes and the transformations system alters in order to accomodate these changes.

Human impacts on the environment derive primarily from the transformation functions. Some of the demand practices (consumption) plus the actions and by-products from transformations can have direct impacts on the biological, physical or chemical attributes of the environment in particular places or globally. These can either enhance or degrade the environment in terms of the provision of a particular range of functions. Transformations tend to enhance benefits to one sector or user (for example the creation and enhancement of duck habitat or planting of forests) and have negative impacts on other functions or other sectors (Manning, 1986a). Pollutants produced in transformation processes can degrade the environment in terms of a broad range of environmental functions. These in turn limit capability to satisfy the demands placed on the environment (e.g. Munn, 1987). This is an iterative process and can result in cumulative and circular

causation resulting in a downward spiral in the environment's capability to satisfy a range of demands. (For example increased population pressures on shifting agricultural systems resulting in complete ecosystem collapse and succession to grassland (Geertz 1966).)

Climate change

Climate change can be viewed as one of the most significant feedbacks from our demands on the resource-base and most particularly from the transformation processes we use. Increased demand for the products of the environment is having severe repercussions on the environmental base. Some of this comes in the satisfaction of direct demand for products of the environment (deforestation to provide fuel and building materials). Much is also caused by the side effects of our transformation processes in the form of, for example, release of chemical materials or forest removal in order to expand the area capable of producing agricultural products. These effects of the consumption and transformation process directly affect the quantity and quality of environment with the ability to support each range of functions. Some transformations can be positive. (e.g. enhanced growing seasons for particular crops or desired products). Other effects can be negative as biological and physical characteristics of specific environments change so that the range of functions is altered or the productivity-response is reduced for certain products. In some cases ability to support specific functions can be eliminated (examples would include the alterations of habitats to the point where specific species can no longer survive, or the removal of flood-control functions due to deforestation or river canalisation).

A sustainable system is one where, over the long-term, the ability of the environment to satisfy the full range of important demands is maintained. Yet we are very aware that through the willful or inadvertant actions of individuals, governments or corporations we are acting to undercut the ability of the environment to supply many vital

functions. Climate change is just one of the major feedback symptoms. Of equal severity are the toxification of major soil areas (Europe), the erosion and desertification of large areas of the world, including significant areas of the southern Canadian prairies, the elimination of much of the world's wetland and rain forest ecosystems, the alteration of human-dominated environments through monocultures with elimination of much ecosystem and genetic diversity. All of these are key issues raised in the World Conservation Strategy (IUCN, 1980) as serious negative impacts on our future capability to maintain a stable and sustainable system.

## Strategies and the System

Conservation strategies enter the picture as a means to try and address concerns with all areas of the system shown in this model. In the past, economic planning, sectoral development planning, social planning and environmental planning (usually through land-use planning approaches) occured quite separately with very little interplay. Conservation strategies can be a means of defining the pathway to the future - a future with a sustainable environment and a productive economy. Conservation strategies are envisioned as a way to set goals and action plans for the sustainable use of resources and the environment using broad scale consensus and comprehensive consultations. Ideally, conservation strategies can be blueprint for sustainable development, helping to define which environmental functions are important. Conservation strategies are means of broadening the planning process to include future concerns, inter-sectoral links and an appreciation of the cross-impacts of the actions which we take (Nelson, 1984). Ideally a conservation strategy defines a balanced and acceptable future (Manning, 1990). It then becomes possible to examine the interplay of the ecological and economic forces through a mechanism like the model we have put forward. This model assists us in identifying the points of intervention where we may have some capacity to alter what is taking place. If we can identify a future which we see to be socially and economically

desirable, and also ecologically feasible over the long term, we can begin to fine tune our system to ensure that we get there from here.

Points of Intervention

Traditionally we have dealt only with the environmental supply - altering those features of the environment necessary to ensure that all our demands are satisfied. But this has proven to be non-sustainable in the long term. What this model shows is that there are many other points of intervention. Fundamental to a successful global outcome will be population control (Brundtland, 1985). The carrying capacity of the planet is highlighted to show that the level of living of individuals will be directly dependent upon our ability to maintain some form of balance. At the same time it is clear that our expectations and attitudes may have to change. Can we alter North-American and Western European perceptions to the point where quantity of goods possessed or consumed is not a key measure of self-esteem? Can we alter demands for packaging and presentation so that huge volumes of wasted materials are not created? Can we make it socially unacceptable to waste and can we alter expectations to be more in line with the ability of the environmental supply on a sustained and equitable basis? These are key challenges for the coming decades.

The current means of transforming environmental resources into goods and services are known have significant negative side effects. Already actions are being taken to eliminate some products which are known to be seriously negative in their impact (chlorofluorocarbons and PCBs are prime examples) but much remains to be done in terms of altering our transformation processes. We need to make them more efficient in terms of resource use, with less waste. We need to seriously examine questions of where they are located, what processes are used and whether re-use, recycling or recapture can reduce the negative impacts on the environment and satisfy the demand side of the equation with less direct draw on environmental functions. This is primarily a technical challenge although it is clear that we must also reexamine many of our institutions, our incentives and our economic system to

make it make economic sense for those who must make the change (Manning, 1986b, 1988b).

## A Spatial Change Approach

Climate change has been a major catalyst for interest in the human/biospere relationship. Because of its global nature, its magnitude and the potential risks involved it is been easier to obtain the attention of industrialists, policy makers and the public. What climate change has done is sensitize individuals to the fact that there is a significant risk of alterations to the ecological systems upon which their welfare depends. One way of portraying these changes is through documenting the potential shifts in the location of ecosystems which currently produce valued products. The map shown in figure 2 is one way of tracing the potential migration of these ecosystems, given a rather small climatic change. What is clear is that the capacity of any given place to serve environmental functions is altered. Another way of looking at this is that the location of environments capable of a particular range productive activity is altered.

## Conclusion

These potential changes and risks are both a stimulus to the development of long term conservation and sustainable development strategies and are key information for the formulation of those strategies if we are looking to risk-reduce our economic and environmental future. Strategy development processes can both identify desirable scenarios and test these against some of the major alterations that can with reasonable probability be expected. Work on the Alternative Futures for Europe project at the IIASA uses the term "not-impossible futures" (Munn, 1988) to describe the range of scenarios which we must be able to anticipate. The current challenge is to find better means to integrate information about these possible transformations into the decision process. Conservation strategies are a key focus for identifying what we consider to be desirable futures and for bringing information on major environmental variables and

FIGURE 2

CHANGING ECOSYSTEM LOCATION UNDER CLIMATIC ALTERATION

ECOCLIMATIC PROVINCES:
OF CANADA: 1990

ECOCLIMATIC PROVINCES:
A 2050 SCENARIO

ECOCLIMATIC PROVINCES

1. ARCTIC
2. SUBARCTIC
3. BOREAL
   - 3a MARITIME BOREAL
   - 3b MOIST CONTINENTAL BOREAL
   - 3c DRY CONTINENTAL BOREAL
4. COOL TEMPERATE
5. MODERATE TEMPERATE
6. TRANSITIONAL GRASSLAND
7. GRASSLAND
8. SEMI-DESERT
9. UNCLASSED, CORDILLERAS NOT SHOWN

changes occuring in them, into the planning process. Only if we are able to successfully combine information on the carrying capacity of the environmental base, the range of demands we are likely to place on it and the impacts of our activities, we will be able to design a future which is both a feasible and desirable, and to make the key interventions necessary to enhance our probability of achieving it.

## BIBLIOGRAPHY


Adamus, P.R. and L.T. Stockwell (1983). A Method for Wetland Functional Assessment. Federal Highway Administration, Washington.

Barbier, Edward B. (1987) "The Concept of Environmental Economic Development" Environmental Conservation 14(2): 101-10.

Bardecki, M., W. Bond and E.W. Manning (1988). Wetland Evaluation and the Decision-Making Process. Ryerson Polytechnical Institute. Toronto. Canada.

Beanlands, G. and P. Duinker (1983). An Ecological Framework for Environmental Impact Assessment in Canada. Dalhousie University, Halifax, Nova Scotia, Canada.

Bond, W.K., H.C. Bruneau and P.D. Bircham (1986). Federal Programs with the Potential to Significantly Affect Canada's Land Resource. Lands Directorate, Environment Canada, Ottawa.

Brundtland (1985). Mandate for Change: Key Issues, Strategy and Workplan. World Commission on Environment and Development. Geneva, Switzerland.

Canadian Council of Resource and Environment Ministers (CCREM). (1987). Report of the National Task Force on Environment and Economy. Ottawa.

Clark, W.C. and R.E. Munn (1986). Sustainable Development of the Biosphere IIASA, Laxenburg, Austria.

Crerar, A. (1986). "Anticipate and Prevent" Policy Options. 3-8.

DeGroot, R.S. (1986). A Functional Ecosystem Evaluation Method as a Tool in Environmental Planning and Decision-Making. Nature Conservation Department, Wageningen Agricultural University, Wageningen, The Netherlands.

DeGroot, R. (1987). "Environmental Functions as a Unifying Concept for Ecology and Economics". The Environmentalist. 7(2): 105-109.

Dunker, P.N. and G.L.K. Baskerville (1986), "A Systematic Approach to Forecasting in Environmental Impact." Journal of Environmental Management. 23: 271-290.

Dorfman, R. (1985). "An Economist's View of Natural Resource and Environmental Problems", in Repetto, R. (ed.) The Global Possible: Resources, Development and the New Century. New Haven: Yale University Press: 67-96.

Fisher, Anthony C. and Krutilla, John V. (1974). "Valuing Long Run Ecological Consequences and Irreversibilities." Journal of Environmental Economics and Management, 1: 96-108.

Geertz, C. (1966). Agricultural Involution: The Process of Ecological Change in Indonesia." University of California Press, Los Angeles.

Gélinas, R. (1988). Development and Application of 'Environomic Units': Hybrid Map Units Designed to Integrate Environmental and Socio-Economic Data for Land Modelling. Lands Directorate, Environment Canada, Ottawa.

Gosselink, J.G. and L.C. Lee (1987). Cumulative Impact Assessment in Bottomland Hardwood Forests. University of Georgia and U.S. Environmental Protection Agency, Washington, D.C.

Holling, C.S. (1986). "The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change", in W.C. Clark and R.E. Munn, Sustainable Development of the Biosphere. IIASA. Laxenburg, Austria: 292-317.

International Union for Conservation of Nature and Natural Resources (1980). World Conservation Strategy. Gland, Switzerland.

Jacobs, P. and D.A. Munro (1987). Conservation with Equity: Strategies for Sustainable Development. IUCN, Cambridge, U.K.

Jackson, W. and W. Berry (eds.) (1984). Meeting the Expectations of the Land: Essays in Sustainable Agriculture and Stewardship. North Point Press. San Francisco.

Knetsch, J. and V. Smith (1984). "Economic Growth, Resource Availability and Environmental Quality." American Economic Review. 74(2).

Land Evaluation Group (1983). Potential Applications of a National Land Evaluation System. Guelph, University School of Rural Planning and Development, Guelph, Ontario.

Land Evaluation Group (1985). Applications of the Prototype Canadian Land Evaluation System. Report N°5 (81-83). University School of Rural Planning and Development, University of Guelph, Guelph, Ontario.

Manning, E.W. (1986a). Towards Sustainable Land Use: A Strategy. Canada-China Bilateral Symposium on Territorial Development and Management, Beijing. Working Paper N°47. Lands Directorate, Environment Canada, Ottawa.

Manning, E.W. (1986b). "Planning Canada's Land Resource Base for Sustainable Development", in Knell, I. and J. English (eds). Canadian Agriculture in Global Context. (Centre on Foreign Policy and Federalism) University of Waterloo. Waterloo, Ontario.

Manning, E.W. (1987). "Models and the Decision-Maker", in Gélinas et al. (1987). Perspectives on Land Modelling. Guelph Occasional Papers in Geography N°3. Guelph, Ontario.

Manning, E.W. (1988a). The Analysis of Land Use Determinants in Support of Sustainable Development. Collaborative Paper 88-1. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Manning, E.W. (1988b). "Soil Conservation: The Barriers to Comprehensive National Response". Prairie Forum, Vol.13 N°1: 99-121.

Manning, E.W. (1990). "Conservation Strategies: Providing the Vision for Sustainable Development". Alternatives, Vol.16 N°4/Vol.17 N°1: 24-29.

McCuaig, J.D. and E.W. Manning (1982). Agricultural Land Use Change in Canada: Process and Consequences. Land Use in Canada Series N°21. Lands Directorate, Environment Canada. Ottawa.

Munn, R.E. (1987). Environmental Prospects for the Next Century: Implications for Long-Term Policy and Research Strategies. IIASA, Laxenburg, Austria.

Nelson, R. (1984). Preparing for a Changing Future: A Catalogue and Analysis of 'Future Oriented' Work Undertaken by Canadian Governments. Square I Management, Ottawa.

Peterson, E.B. et al. (1987). Cumulative Effects Assessment in Canada: An Agenda for Action and Research. Canadian Environmental Assessment Advisory Council. Ottawa.

Smit, B. (1981). Procedures for the Long-Term Evaluation of Rural Land. Land Evaluation Project Team, University School of Rural Planning, CRD Publications 105, University of Guelph. Guelph, Ontario.

Smit, B. and M. Brklacich (1985). Feasibility of Constructing a Multisector Land Evaluation System: The New Brunswick Pilot Study. Working Paper N°42. Lands Directorate, Environment Canada, Ottawa.

Williams, P. (1987). Adapting Water Resources Management to Global Climate Change. International Institute for Energy, Resources and the Human Environment and Royal Swedish Academy of Sciences. Stockholm.